Corrosion in offshore wind energy: assessment of marine aerosol concentration using the CALIOPE air quality modelling system

PO.287

Presenting author: Albert Soret[1],
Co-authors: Daniel Ortega[1], Maria Teresa Pay[1], Llorenç Lledó[1] and Daniel Cabezón[2]
[1] Barcelona Supercomputing Center, Barcelona, Spain [2] EDP Renováveis EU, Madrid, Spain

Introduction

Sea salt aerosols affect metallic structures. Offshore wind turbines are exposed to corrosive attack affecting their efficiency and their components' lifetime.

According to the specications in ISO9226 and ISO9223, data on the corrosivity of the atmosphere are essential for the development and specication of optimized corrosion protection for manufactured products.

Fig 1. The Great Wave off Kanagawa, woodblock print by the Japanese ukiyo-e artist Hokusai

Since 1) there are only a few observations of atmospheric composition and 2) corrosivity determination tests need long exposition periods model systems can be a useful tool to assess corrosion conditions. This work demonstrates that air quality modeling systems such as CALIOPE can provide predictions of the atmospheric composition and meteorological conditions.

Methods and evaluation

Marine aerosol concentration in Europe is assessed by using the CALIOPE air quality modelling system (**http://www.bsc.es/caliope/en?language=en**). The system integrates the WRF-ARW meteorological model coupled with the CMAQv5.0.2 photochemical model. For this study, anthropogenic emissions come from the EURODELTA-trend exercise where annual totals are estimated by the GAINS model and spatialization and disaggregation are processed by the Institut National de l'Environnement Industriel et des Risques (INERIS).

The simulations are run for three years (Fig. 2): 1990, 2000 and 2010, which have been selected to representatively cover periods of high (1990), normal (2000) and low (2010) wind speeds in the region of study (Northern Europe). Sodium, chloride and total sulfate aerosols are studied. A comprehensive evaluation of the model is performed using aerosol observational data from the EBAS database (http://ebas.nilu.no) for locations subjected to conditions similar to the marine atmosphere of the area of study (Fig. 3).

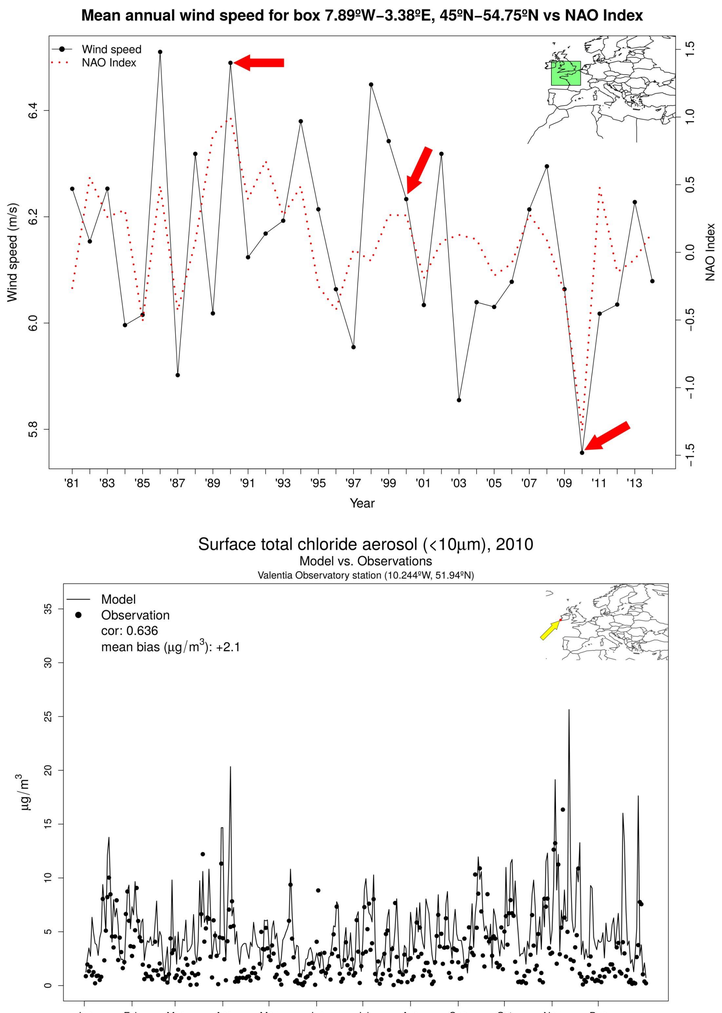

Fig 2. Mean annual wind speed versus NAO index for 1981-2014. Wind speed for lon-lat box 7.89oW-3.38oE, 45oN-54.75oN. NAO index is Hurrell's PC-based NAO index. Wind speed in m/s. Wind speed as solid black line, NAO index as dotted red line. Years of study marked with red arrows.

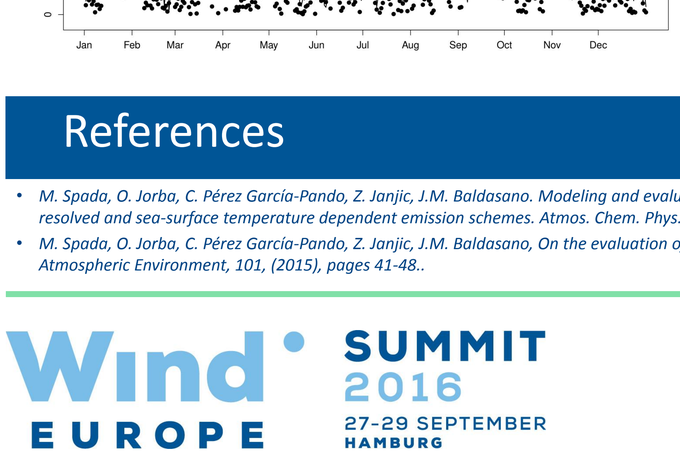

Fig. 3. Example of the evaluation. Time series of daily surface total chloride aerosol for Valentia Observatory station, Ireland (10.244oW, 51.94oN) for year 2010. Observations as black dots. Model as black line. Particle size below 10 micrometers. Units in micrograms per cubic meter.

References

- *M. Spada, O. Jorba, C. Pérez García-Pando, Z. Janjic, J.M. Baldasano. Modeling and evaluation of the global sea-salt aerosol distribution: sensitivity to size-resolved and sea-surface temperature dependent emission schemes. Atmos. Chem. Phys., 13 (2013), pages 11735–11755.*
- *M. Spada, O. Jorba, C. Pérez García-Pando, Z. Janjic, J.M. Baldasano, On the evaluation of global sea-salt aerosol models at coastal/orographic sites, Atmospheric Environment, 101, (2015), pages 41-48..*

Results

This study has been motivated by the interest of EDPR in assessing marine aerosol concentration in a specific location in Europe where a new wind farm is under consideration. For this specific location a comprehensive statistical characterization of marine aerosol concentration has been also provided.

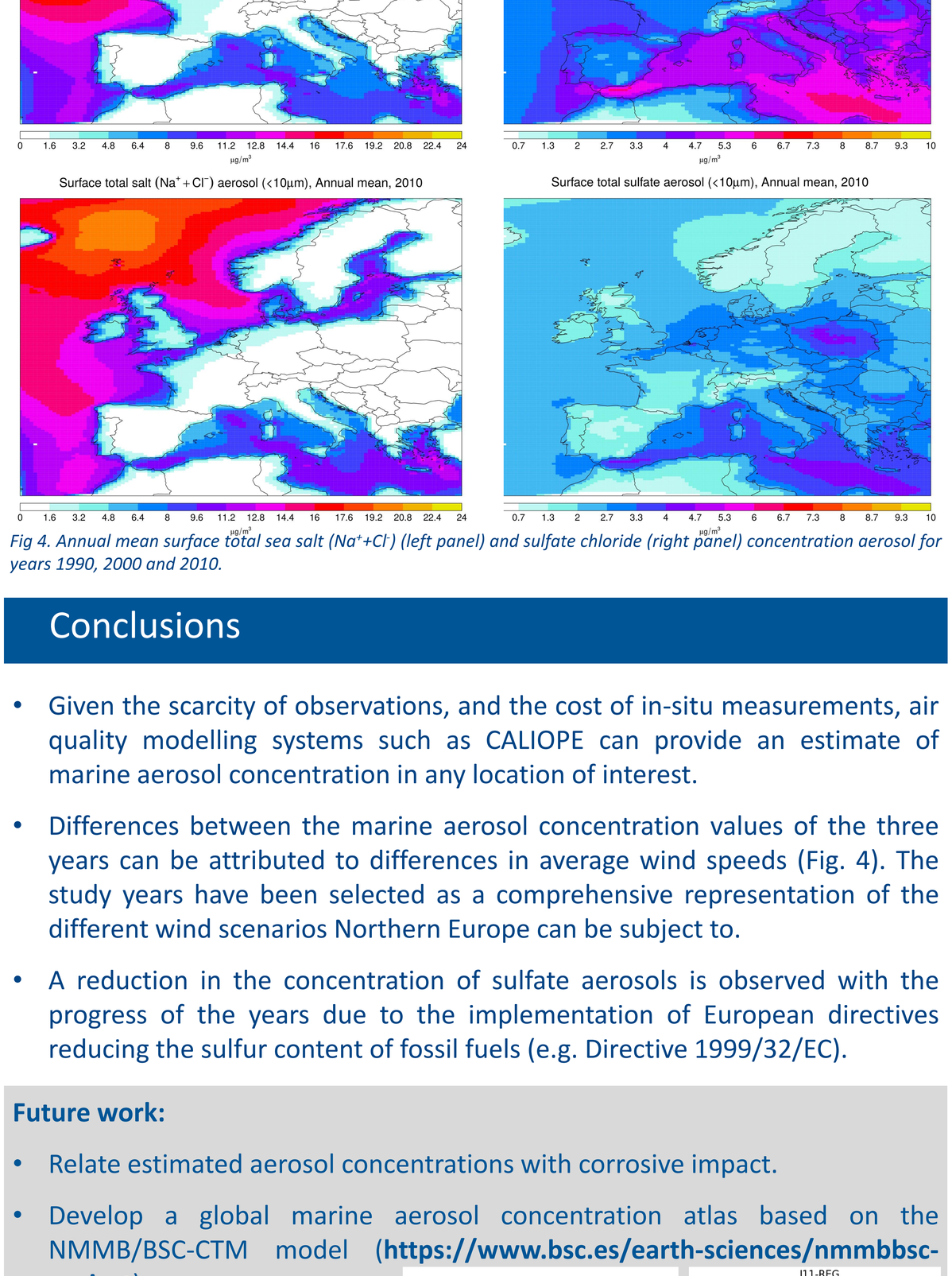

Fig 4. Annual mean surface total sea salt (Na^++Cl^-) (left panel) and sulfate chloride (right panel) concentration aerosol for years 1990, 2000 and 2010.

Conclusions

- Given the scarcity of observations, and the cost of in-situ measurements, air quality modelling systems such as CALIOPE can provide an estimate of marine aerosol concentration in any location of interest.
- Differences between the marine aerosol concentration values of the three years can be attributed to differences in average wind speeds (Fig. 4). The study years have been selected as a comprehensive representation of the different wind scenarios Northern Europe can be subject to.
- A reduction in the concentration of sulfate aerosols is observed with the progress of the years due to the implementation of European directives reducing the sulfur content of fossil fuels (e.g. Directive 1999/32/EC).

Future work:

- Relate estimated aerosol concentrations with corrosive impact.
- Develop a global marine aerosol concentration atlas based on the NMMB/BSC-CTM model (**https://www.bsc.es/earth-sciences/nmmbbsc-project**).

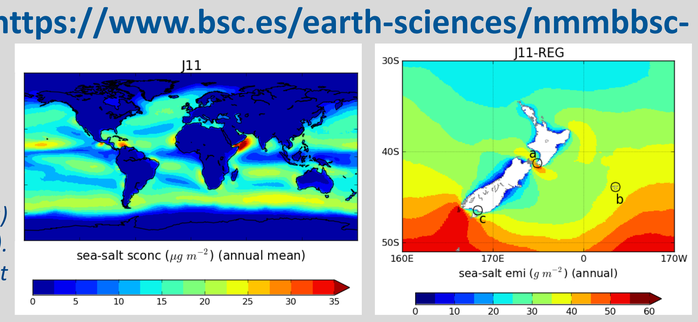

Fig 5. Annual mean surface total sea salt (Na^++Cl^-) using the NMM-BSC/CTM model (left panel). Detail of sea salt emission in New Zeland (right panel). Source: Spada et al., 2013 and 2015